American forestry

Washington, D.C.: American Forestry Association, 1910-1923.

https://hdl.handle.net/2027/mdp.39015004586445



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DISCOVERY OF SUGAR ON DOUGLAS FIR

BY FRANCIS DICKIE

ONG before the first white man came to North America with his luxuries of sugar and tea and other food delicacies which today the Indians love, and long for when without, the Indians of at least one district on this great continent had a white sugar of a

very rare and high quality, a sugar derived from the strangest, and an almost unbelievable source-from the foliage of the Douglas fir tree, growing in certain districts in the Province of British Columbia, Canada. Yet, remarkable as this botanical phenomenon is, the existence of sugar in such an unusual place as the foliage of a coniferous tree seems to have entirely escaped the attention of all the white traders, explorers, surveyors, missionaries and hunters who passed through the regions where it is found. At least no mention of it has ever come to light; nothing seems to have been written of it by those early pioneering whites who traveled through the region where the trees produce this sugar; and, undoubtedly, had these men known of it, they would most certainly have made some mention, because of the very unusualness of the occurence.

So, in spite of the fact that this sugar has been known to and used by the Indians for a great many years, it is only now that the following interesting scientific facts of this phenomenon in the plant

world are made available through the investigations and experiment of Professor John Davidson, F. L. S., F. B. S. E., Botanist in charge at the University of British Columbia, Vancouver, Canada, who has recently made a careful study of the sugar deposits on the fir, and the conditions under which it is formed, by visiting

some of the principal regions where grow these sugar bearing trees. Assisted by James Teit, of Spence's Bridge, British Columbia, who had spent the major portion of his years living in the interior of the Province, and who had an intimate knowledge of the country and

the Indians, Professor Davidson gathered the data as to the districts where the sugar chiefly is found, the probable causes of it, and the other interesting matter which is the subject of this article, wherein for the first time the story of the discovery is made known to the general reading public.

The sugar appears in white masses of different sizes, ranging from a quarter of an inch to two inches in diameter. The smaller masses form like white drops at the tips of single leaves, and also at times several of the leaf tips are imbedded in a larger drop. Masses of greater size scatter over the leaves and branchlets. Placed in the mouth the sugar is exceedingly sweet, giving a flavor comparable to the highest class of the manufactured article. For a moment it passes into a pasty consistency in the mouth. But quickly becomes entirely soluble under the action of the saliva. It is quite hard and dry, but with no tendency to stickiness, after the manner of coarse flour. The accompanying photo taken by Professor Davidson, is of a good average

A RARE PHENOMENON-SUGAR ON FIR

The sugar appears in white masses of different sizes, ranging from a quarter of an inch to two inches in diameter. The smaller masses form like white drops at the tips of single leaves, while masses of greater size scatter over the leaves and branchlets.

specimen of the phenomenon as it occurs on the Douglas fir in British Columbia. A very light rain is, however, sufficient to dissolve the sugar off the fir; but very often it recrystalizes on the ground. At other times it remains in a semi-fluid condition, and its food value is evidenced by the fact that flies and various other insects are attract-

ed to it and feed upon it. The principal regions where Professor Davidson's investigations show the sugar to be produced are in the hottest and dryest parts of the interior of British Columbia, between the 50th and 51st parallels, and between 121 and 122 longitude. These areas take in the Thompson River Valley, west of the mouth of the Nicola River, the district near the junction of the Fraser and Thompson Rivers at Lytton, and a small part of the Fraser Valley, above Lillooett. In the Kamloops district, the Nicola and Similkameen Valleys and the eastern part of the State of Washington it is also reported to occur.

On first viewing the phenomenon, Professor Davidson was inclined to think the sugar resulted from punctures made in the leaves by insects, probably aphides, as he knew the Tamarix mannifera yielded a mucilage-like sugar when attacked by the Coccus-as a result of which came the manna of Mt. Sinai. However, this idea was quickly dispelled when he found only healthy Douglas fir yielded a sugar harvest, ones practically free of any insect life. Thus the phenomenon was evidently the result of natural causes, turning the investigator's attention to an examination of hours of sunlight, amount of moisture usually existing and similar things. This resulted in the finding that in the above mentioned districts of the dry-belt on gentle slopes facing east and north in comparatively open areas where the fir trees got plenty of exposure to sun, the sugar producing trees chiefly grew. Where the firs stand densely, or where the trees are on fully exposed southern and western slopes the sugar is not generally found, as the ground in this latter area dries out very quickly. From this it was evident that moisture played an important part in the sugar's production when combined with certain requisites of sunlight. Where a great many leaves are exposed to the sun, as in the case of the firs standing on comparatively open areas on the slopes facing east and north, an abundant formation of carbohydrates occur in a day. In the ordinary course of nature's working these carbohydrates would be carried to the growing tissues or storage ones, which is the case on Douglas fir in heavily forested areas. But throughout the dry-lelt region the trees receive a much greater amount of sunlight over a greater number of hours per day than in other localities where they grow. Here, in the dry-belt, the ground and atmosphere are also warmer, the air circulates more freely than in the coastal regions where the dense fir forests stand. Thus in the dry-belt where the firs are subjected to a long succession of unclouded days of blazing sunlight in summer, and where the soil condition provided warmth and moisture, the trees gather a great deal more carbohydrates than normally. The soil's increasing warmth over so great a period of sunlight permits the roots to maintain or increase activity and continue nocturnally. This increased root pressure, and cessation of transpiration, causes the leaves to become water-gorged. This water contains a sugar created by the reconversion of starch into sugar. But the warm, dry atmosphere existing even through the night in these dry-belt regions,

quickly evaporates the water, and the sugar remains to form drops of various sizes deposited at the leaf tips, some of which so large they fall onto branches and foliage below, resulting at times in irregular deposits as shown in the photograph.

By reason of the necessity for a succession of sunshiny days to produce the sugar, the Douglas fir of course does not yield a harvest that could annually be depended upon. For, a couple of wet days, or a few cloudy ones are sufficient to disarrange those atmospheric conditions which make the sugar possible. A cloudy day would permit the tree to utilize in the regular way much of the excess sugar and to horde the remaining portion as a future food reserve. A day or more marked by a drop in temperature would check the labor of the sugar-forming cells in the leaves, and the diminishing of the soil's heat lessen the root activity, causing a diminishing in the exudation of the water and a lowering of the root pressure. Similarly a day of rain would still more lower the soil temperature as well as that of the atmosphere. For these reasons the sugar cannot be depended upon to yield an annual harvest. This the Indians knew, and in good years stored up as much of the delicacy as was obtainable. The following analysis, made by Dr. F. T. Shutt, Dominion Chemist, Ottawa, Canada, and by the Bureau of Chemistry Washington, D. C., where there is a laboratory specially equipped for the examination of saccharine substances, are of great interest by the high degree of constancy of composition the fir sugar, or manna, showed. It is still more interesting owing to the finding that it contains a large percentage of an extremely rare variety of sugar; indeed, this particular variety is more abundant in the product of the Douglas fir than any other known plant. It was formerly obtained from a shrub in Turkestan and Persia. Of this pure and rare trisaccharide the Douglas fir sugar contains almost fifty per cent. Thus, while the fir sugar will never play a part as a food supply, like the product of the cane and beet, it will likely eventually prove valuable for use in chemistry, and perhaps in other ways which the scientific experimenting conducted by those interested in the discovery will bring to light. And in the heart of British Columbia the Indians will still gather it as they did before the white man came. Unique as the discovery is, it is further remarkable that so long a time elapsed before it attracted scientific attention as related herein. Perhaps the Indians intentionally held the fact a

Of this Douglas fir manna, as it is called, the weekly bulletin of the Forest Service, District No. 1, at Missoula. Montana, says: "An interesting phenomenon which few of us have probably observed is the occurrence of 'firsugar' or Douglas fir manna, which is occasionally formed during summer droughts, or in dry-belt regions on the leaves and twigs of the Douglas fir.

"According to information from published records which have been furnished by Dr. Weir, the manna is not the result of the activities of insects, but is a natural exudation from the tips of the needles. The manna is



said to crystallize in some instances, cementing the twigs and leaves together in conspicuous masses. A slight rain quickly dissolves the manna from the branches and it may be found recrystallized in patches at the base of the tree.

"A letter from the Madison Laboratory states that the manna from Douglas fir contains about fifty per cent of a sugar known as melezitose, which in small quantities is selling at \$66 a pound. A correspondent had made a request for approximately ten pounds and estimated that three to five dollars per pound could be paid for the collection of this material. It was suggested by the Laboratory that on the basis of the price and yield of melezitose, a higher price than this might be paid.

"The Douglas fir manna cannot be relied upon as an annual crop. Dr. Weir has seen the manna but twice,

once in the fall of 1915 somewhere along the Yaak River on the Kootenai, and in 1916, when he observed and examined a white, sweetish exudation from the branches of a Douglas fir near Metalline, Washington. He doubts very much if it can be found in sufficient quantity for collecting in this region. A search for the material would necessarily be made during the dry periods of the year.

"In an article on 'Douglas Fir Sugar,' by Professor J. Davidson, of the University of British Columbia, it is reported that the region in which sugar-bearing Douglas firs are most abundant lies between the 50th and 51st parallels and between 121°-122° longitude. This includes the driest and hottest part of the dry-belt of British Columbia."

A FOREST FIRE

THE following word picture of a forest fire appears in the report of the Ontario Game and Fisheries Commission. It is a graphic description of the mighty tragedy:

"To the average man, no doubt, the reading of the destruction of miles of standing forests conveys but little of its true significance. He can hardly appreciate the gigantic figures arrayed before him as to the square feet of timber burnt or the estimated value of the same in millions of dollars. He may perhaps be aghast at the loss of life or suffering and hardships endured by those who were fortunate enough to escape their flames. He may even dimly realize that these people have lost their homes, their possessions, their all. But the effects on nature are as a closed book to him. He has not seen; he cannot understand.

"The stately forest, stretching unbroken for miles, harbors countless wild animals, birds and insects. Life, indeed, is seething in it. The soil on which it stands is nursed and enriched by its fallen foliage and trees, which in many instances cover even the bare rocks sufficiently to allow of the seeds taking root right over them and which form always a natural basin where the raindrops may fall and accumulate, to percolate subsequently into the crevices of the rocks, from which again they will appear in the form of a gushing spring. Just as on the even outpouring of the spring will depend the flow of the brook, the stream and the river, so does the spring itself depend on the existence of its damp and mossy forest reservoir for its waters. The forest fire is capable of destroying all: animals, birds, insects, vegetation and The voice of the forest is hushed, and the death of the trees is not only accompanied by the annihilation of one of nature's great water storages, so vital to the prosperity of some perhaps far distant agricultural community, but by the disappearance of an important factor

in the regulation of both climate and rainfall over a considerable region.

"The picture of a forest destroyed by fire almost baffles description in its appalling horror. Unrelieved by the accustomed sounds, the cheerful note of songbirds, the chirruping of squirrels or chipmunks, the calls of animals or the humming of insects, deathly silence regins oppressive and supreme. Great trees and small trees alike, black, bare and gaunt, stand shivering as the breeze soughs a mournful dirge through their ranks, ghastly skeletons of nature's once beautiful handiwork, or else lie prostrate on the ground, charred, burnt and shrivelled, grim spectres of a useful past, proclaiming the passage of ruthless death, the advent of desolation and decay. No butterfly or moth flutters over the withered and blackened leaves; no little creature or insect crawls from among them, startled by the approaching footfalls. Far down into the accumulation of twigs and decaying vegetation which has formed the forest bed, into the mossy and spongy soil which in the past has held water to furnish life to the trees growing on it, the relentless fire has eaten its way and left its train a mass of useless cinders from which all nutriment has been utterly scorched. The human visitor to this tragic scene will have himself alone for company; will hear his own breathing; will be conscious of his own heartbeats; will be almost terrified at the sounds of his own footsteps; for life has been extinguished, the silence of the grave will surround him, and it will seem almost sacrilege to break the all pervading quiet of the dead. In due course the action of the winds will blow away the cinders, and the bare rocks over which once grew the forest will be exposed to view in all their unbeautiful and grim nakedness, and the region will remain barren and in all probability useless to man's welfare until, perhaps, after the lapse of centuries nature once again shall have succeeded with indomitable patience in recovering the rocks with a fresh soil."

